Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Loads (TMDLs)

for

Dark Creek
Randolph County, Missouri

Completed: November 29, 2004
Approved: December 15, 2004

Total Maximum Daily Load (TMDL)
For Dark Creek
Pollutant: Sulfate

Name: Dark Creek


State map showing location of watershed

Location: Randolph County near Clifton Hill and Huntsville, Missouri

Hydrologic Unit Code (HUC): 10280203-040002

Water Body Identification (WBID): 0690

Missouri Stream Class: C[1]

Beneficial uses:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health associated with Fish Consumption

Size of Impaired Segment: 8 miles

Legal Description of Impaired Segment: The upstream end of this segment is in W1/2, Section 34, T55N, R15W and the downstream end in NE ¼, Section 31, T54N, R15W at its mouth, where it empties into the East Fork of the Chariton River.

Pollutants: Sulfate

Pollutant Source: Crutchfield Abandoned Mine Lands

TMDL Priority Ranking: Medium

1. Background and Water Quality Problems

Area History[2]:
Dark Creek originates in the northwest quarter of Randolph County. It flows southwesterly into the East Fork of the Chariton River, where it is a major tributary. The legal descriptions for the upstream and downstream end of the impaired segment are given above. In 1821, William Elliott was hunting in the township when night over took him. He camped all night on the banks of this creek. He said it was the darkest night he ever saw; hence the name Dark Creek. The little town of Darksville, in the upper Dark Creek watershed, takes its name from the creek.

[1] Class C streams may cease to flow in dry periods but maintain permanent pools that support aquatic life. See 10 CSR 20-7.031(1)(F)
[2] History of the Moberly Area, http://www.moberly.com/chamber/history.htm

Randolph County was named for John Randolph, Virginia statesman and an early advocate of the States' Rights doctrine. He served in the U.S. Senate from 1825 –1827. In 1829, Randolph County was carved from its neighbor to the west, Chariton County, which in turn was carved from Howard County to the south in 1820. Eight years after it was formed, in 1837, a chunk of Randolph County helped create Macon County to the north. Pioneers from the southern states of Kentucky, Tennessee and Virginia settled the county, so the area became known as Little Dixie. Some settlers were slave owners while others were strict abolitionists. Even though no major battles were fought on county soil during the Civil War, the war took its toll. Randolph County lives were lost and the North Missouri Railroad Company, with its north-south line, was a target of both sides.

A unique geographic feature of the county is the "great divide". This high ridge of land divides the water flowing to the Mississippi River from the water flowing to the Missouri. It stretches from Boone County, Missouri, north into Iowa and is easily distinguished as one travels through the county. Moberly sits on the divide and, because of this, was thought to be safe from tornadoes. This was disproved on July 4, 1995, when a tornado ripped through the center of town.

Soils and Land Use:
The soil association in the bottomland along Dark Creek is the Piopolis-Chequest association. It is a deep, nearly level poorly drained silty-clay loam. It has moderate to slow permeability and slow runoff. Lagonda, Gorin and Keswick silt loams with 5-9 percent slopes are found on the side slopes. These are deep soils, eroded and somewhat poorly drained. They have slow permeability and moderate runoff. The former Crutchfield mine land contains the Bethesda shaley silt loam with slopes of 9-20 and 20-70 percent. It is a deep, well-drained soil on mine spoils that has been leveled and shaped somewhat.

Fifty-one percent of the land in the watershed is in grasslands. Thirty-five percent is in row and close-growing crops and 12 percent is forest and woodland. The land of the former strip mines is mainly in grasses and may not be as productive as land that has never been mined.

Defining the Problem:
The Crutchfield Abandoned Mine Land (AML) area was strip mined in the 1950's[3]. It includes approximately 1700 acres. Strip mining of coal has a significant effect on the near-surface environment because overburden (rock and soil above the coal seams) is removed successively in furrows or strips. After the first strip is cut, the broken and mixed overburden from successive cuts is placed into the previous cut and forms "spoil". Problems occur when sulfide minerals in the spoil oxidize in the presence of water and oxygen to form highly acidic (low pH), iron- and sulfate-rich drainage. Both low pH and high levels of sulfate are harmful to aquatic life. There are many types of sulfide minerals, with pyrite and marcasite being the iron sulfides most common in coal regions. These minerals are found in the overburden in the Dark Creek area and, while low pH is not a problem, high levels of sulfate contaminate the creek. See Appendix B for a map of the creek showing the location of the mined land.

[3] Phase II Problem Area Data Sheet, P.A. ID number MO-051, Land Reclamation Program, Missouri Department of Natural Resources, June 26, 1980.

Before 1972, reclamation of land stripped by mining was not required and ordinarily was not practiced in Missouri mining operations. Finally, Public Law 95-87 (U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement, 1979) was enacted, which requires that strip mined lands be reclaimed. The Crutchfield mines were in existence before 1979, and so they are referred to as "pre-law" mines. This means the companies that operated the mines are not responsible for reclamation. In 1990, at a cost of $1,213,004, the department's Land Reclamation Program conducted a reclamation project totaling 162 acres on the coal waste areas in the Crutchfield AML. This project was accomplished mainly by re-contouring the surface of the land, eliminating acid ponds, burying acid-forming spoils and establishing permanent vegetation. Specifically listed in the project report is removal of one hazardous impoundment, improvement of water quality in two miles of stream and reclamation of one acre of acidic impoundments, 129 acres of spoil, 16 acres of slurry (very fine material left from the washing process), six acres of gob (heavier material from washing) and 10 acres of "other" (non-acid impoundments, facilities, haul roads, etc).

At present, the land is used primarily for grazing and may not be as productive as land that has never been mined. Since the reclamation, new sulfate and chloride materials are exposed to air and water every time soil is removed through erosion. Because of this, the runoff is considered Acid Soil Erosion instead of Acid Mine Drainage. This sulfate-rich runoff negatively affects the water quality in Dark Creek.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Target

Beneficial Uses[4]:
The beneficial uses of Dark Creek, WBID 690, are:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health associated with Fish Consumption

Use That is Impaired:
Protection of Warm Water Aquatic Life

Anti-degradation policy:
Missouri's Water Quality Standards include the Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first Water Quality Standards Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than

[4] 10 CSR20-7.031(1)(C) and Table H

required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and State parks and wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria:
Sulfate and chloride are linked together in Missouri's Water Quality Standards (WQS). Section (4)(L)1 only concerns streams with 7Q10 low flow[5] of less than one cubic foot per second (cfs). Here it states that the concentration of sulfate plus chloride ($S0_4$ + Cl) shall not exceed 1000 milligrams per liter (mg/L) for protection of aquatic life.

Numeric Water Quality Target:
Sulfate and chloride criteria for the protection of aquatic life are linked in Missouri's Water Quality Standards. Dark Creek has a 7Q10 low flow of less than one (1) cubic foot per second, therefore the in-stream concentration of chloride plus sulfate in the creek shall not exceed one thousand milligrams per liter (1000 mg/l), as per the standard stated above.

3. Loading Capacity

The Loading Capacity (LC) is the greatest amount of pollutant loading that a stream can assimilate without becoming impaired. It is equal to the sum of the Load Allocation (LA), the Wasteload Allocation (WLA) and the Margin of Safety (MOS) and can be expressed as an equation:

$$\mathbf{LC = LA + WLA + MOS}$$

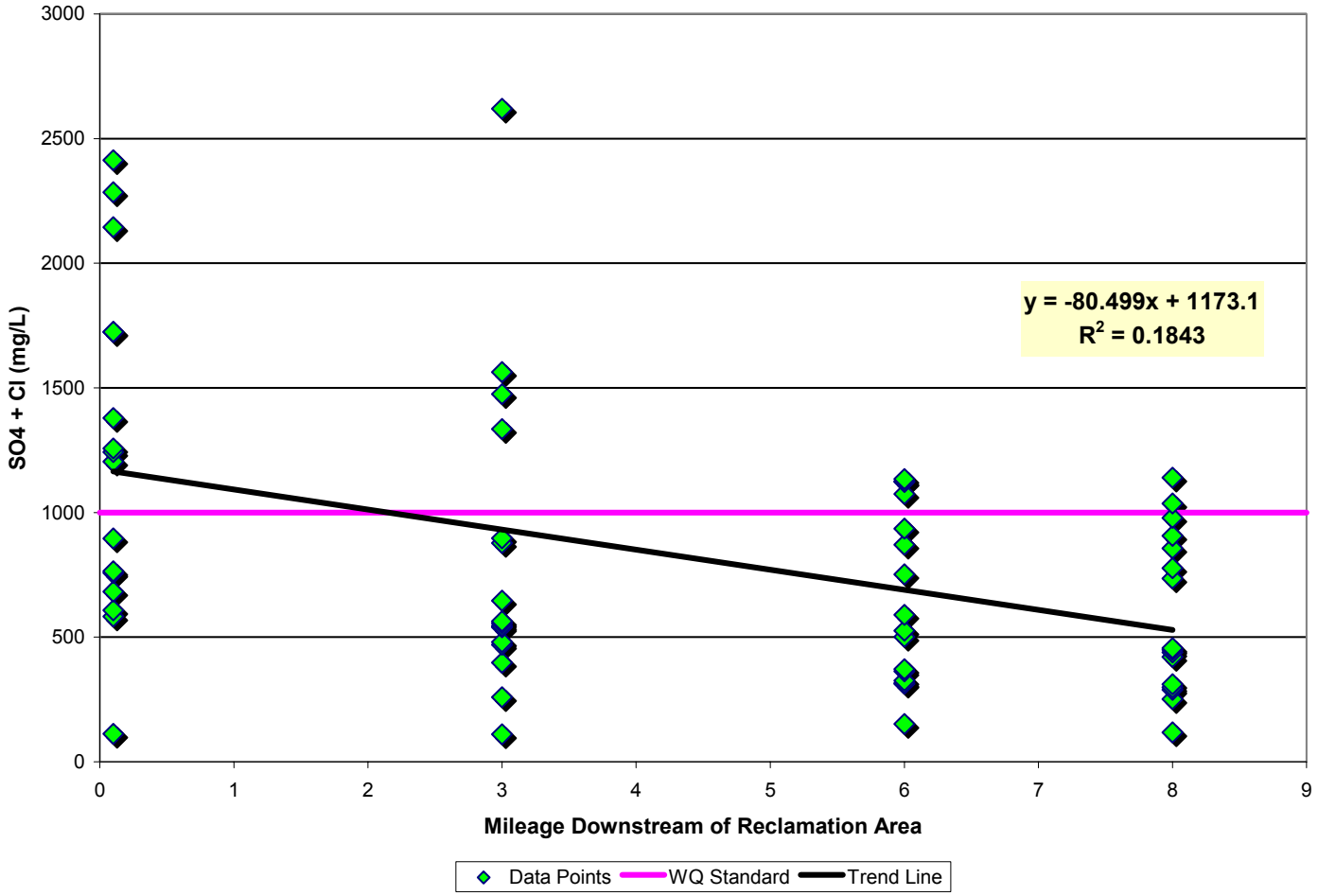
Dry weather critical flow from the Crutchfield AML can not be accurately determined because surface flow from this area is variable. This creek is a Class C stream, which ceases to flow in dry periods but maintains permanent pools that support aquatic life. Dry weather critical flow is therefore 0.1 cfs or less. Since there can be minimal upstream dilution during dry weather conditions, the flow of water (Acid Soil Erosion) coming from these AML areas will have to meet in-stream water quality standards for sulfate plus chloride of 1000 mg/L.

TMDL Development:
The TMDL is expressed in terms of reduction of the existing concentration to meet the criterion. Statistical analysis of the data (see Appendix C) showed that there is no correlation between sulfate concentration and chloride concentration for all sites (see map in Appendix B). Both sulfate and

[5] 7Q10 is the lowest average flow for seven consecutive days with a recurrence interval of ten years.

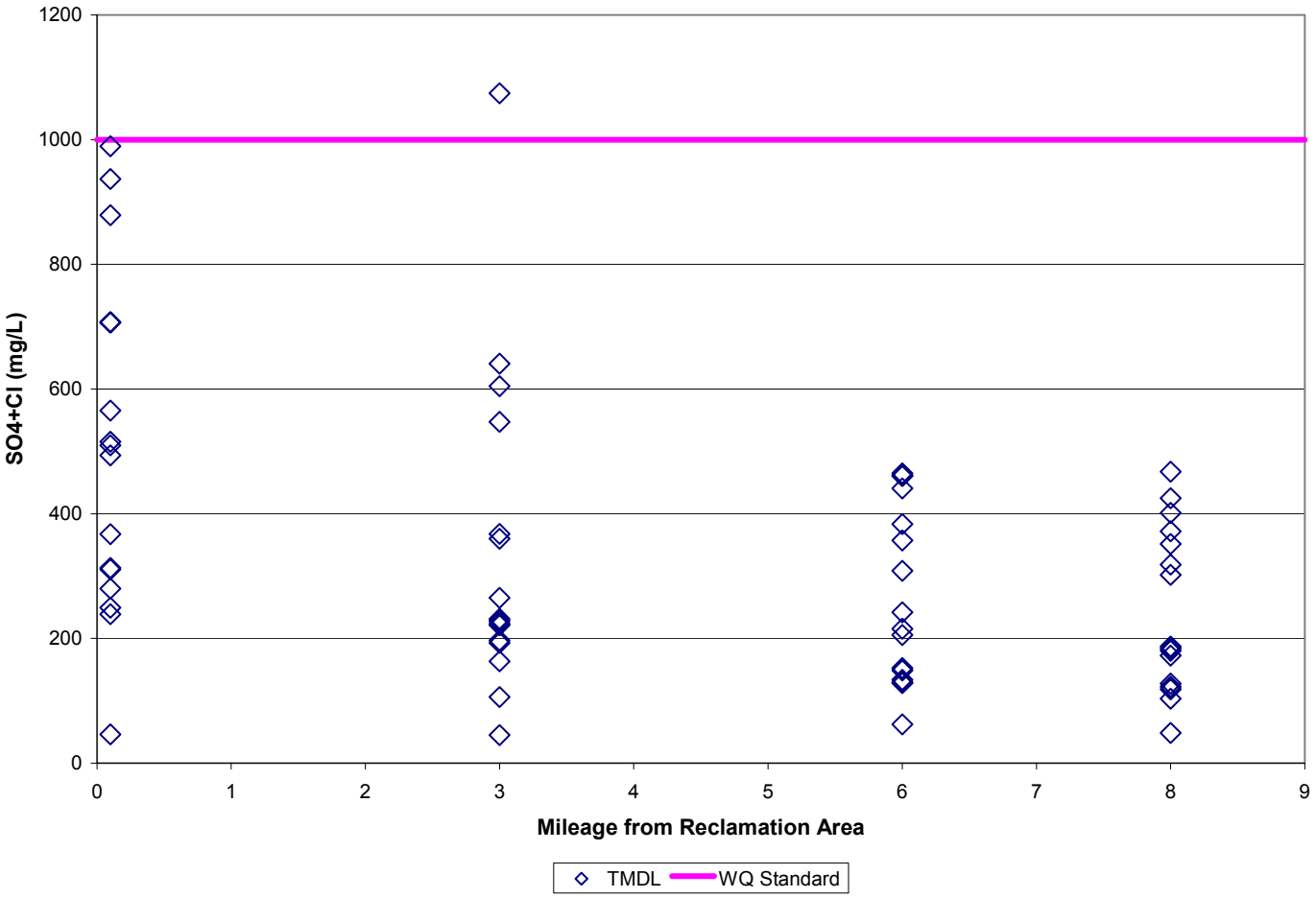
chloride concentrations are correlated with site location (ρ ($S0_4$) = -0.42 and ρ(Cl) = -0.32). The correlation between the sum of $S0_4$ + Cl and site location is also –0.42. This means that the closer a site is to the AML area, the higher the sulfate plus chloride concentration. Figure 1 shows this negative relationship between site location and sulfate plus chloride concentration.

Figure 1. Sulfate plus Chloride Concentration Grouped by Site



Because of this correlation, the site closest to the reclaimed area (Site 1, which is within the AML about 0.1 mile downstream of the reclamation area) was used to calculate the TMDL. This was done as a reduction in sulfate plus chloride concentration. Using Site #1 data from 2000 to 2004, the maximum measured concentration of sulfate plus chloride (the highest data point) was picked (2,413 mg/L). Bringing this value down to the Standard computes to a 59 percent reduction [(2413 –1000)/2413 = 0.59]. The result is that a 59 percent reduction in sulfate plus chloride concentration is needed to meet WQS in Dark Creek. If the upstream-most site is reduced by 59 percent to meet water quality standards, the other downstream sites will be reduced by as much. Figure 2 shows the expected concentration of sulfate plus chloride in Dark Creek after a 59 percent reduction.

Figure 2. TMDL (59 Percent Reduction) Per Site and the Water Quality Standard



4. Load Allocations (Nonpoint Source Load)

Load Allocation (LA) is the maximum allowable amount of the pollutant that can be assigned to nonpoint sources. Surface erosion is the main cause for sulfate entrainment in the stream. Consequently, stream loading is dependent on rain intensity and duration, soil cover, and soil moisture content. It becomes obvious that if soil erosion is minimized, sulfate concentration in the stream will diminish. The LA will be the instream $S0_4$ + Cl concentration of 1000 mg/L.

5. Wasteload Allocation (Point Source Load)

The Wasteload Allocation (WLA) is the maximum allowable amount of the pollutant that can be assigned to point sources. There are presently no point source discharges that would impact sulfate in Dark Creek; therefore, the WLA is zero for sulfate plus chloride. Any future discharges would be required by a Missouri State Operating Permit to maintain a sulfate plus chloride concentration of 1000 mg/L or less.

6. Margin of Safety (MOS)

A Margin of Safety (MOS) is required in the TMDL calculation to account for uncertainties in scientific and technical understanding of water quality in natural systems. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
(2) Implicit - Incorporate the MOS as part of the critical conditions for the waste load allocation and the load allocation calculations by making conservative assumptions in the analysis.

The MOS for this TMDL is implicit through conservative assumptions in the analyses. These are expressed in using the maximum measured concentration at Site 1, and applying the reduction to all sites. This is the most conservative assumption, and supplies a good MOS. If future in-stream monitoring indicates applicable water quality standards are exceeded, the TMDL will be reopened and the MOS re-evaluated based on additional data.

7. Seasonal Variation

The water quality data collected to this point represents all seasons. While the critical condition is during periods of surface runoff, the LA and TMDL are applicable at all flow conditions, hence all seasons. Also, the primary processes involved in the oxidation of sulfide are not significantly impacted by differences in air and water temperatures associated with seasonal change. Therefore, Missouri standards do not distinguish between summer and winter for sulfate.

8. Monitoring Plan for TMDLs Developed Under the Phased Approach

There is no adequate data to accurately link sulfate-plus-chloride concentration to water quality in Dark Creek. Because of this data deficiency, continued stream monitoring, regular aquatic life evaluation, and improvement of watershed management are necessary to restore water quality standards in the Creek. Dark Creek is presently included in the department's continuous monitoring plan. The Northeast Regional Office (NERO) samples these sites two times a year for a variety of stated parameters.

Organization	Monitoring Type	Waterbody Name	Site Number	Status	Fld	Mi	Comments
MDNR	Ambient (NERO)	Dark Cr. @ Hwy C-Randolph Co.	1	Ongoing	2	2	Chloride, Sulfate
MDNR	Ambient (NERO)	Dark Cr. @ Hwy Z-Randolph Co.	2	Ongoing	2	2	Chloride, Sulfate
MDNR	Ambient (NERO)	Dark Cr. center Sec. 30,T54N,R15W	3	Ongoing	2	2	Chloride, Sulfate
MDNR	Ambient (NERO)	Dark Cr. NE,NE,NW Sec.20,T54N,R15W	4	Ongoing	2	2	Chloride, Sulfate

The Site Number corresponds to the sites on the map of the impaired segment in Appendix B. The number "2" in the other fields is the frequency or how many times monitoring will be done per year. The headings are defined as follows:

Fld – Field Measurements. These are measurements made in the field and include water temperature, pH and specific conductance.
Mi -- Major ions and allied measurements. These include chemical analysis for calcium, magnesium, sulfate, chloride and bicarbonate and determination of alkalinity/acidity. The particular analytes for these sites are listed in the Comments column.

9. Implementation Plans

As stated earlier, a reclamation project costing more than $1.2 million was completed in Dark Creek in 1990. As with most reclamations, the project has remedied the worst of the problems. What remains to be done is to reduce the amount of sulfate and chloride materials being exposed to air and water through soil erosion activities. Every time soil is removed through erosion on these surface mined lands, new sulfate and chloride materials are exposed to air and water that increases the amount of sulfate-rich runoff entering Dark Creek.

The way to control the Acid Soil Erosion of previously mined land is to install good farming practices. As mentioned previously, the land in the Crutchfield AML was mined prior to1979 and is not the coal mine's regulatory responsibility to improve the land to its prior productive status. The responsibility would then be the present landowner(s) if they desire to improve the productivity of the land. The majority of this pre-mined land is now used for agricultural purposes. Some examples of practices that would help enhance the soil and reduce soil erosion include: soil testing, pH adjustment (lime), keeping cattle off the less vegetated areas (livestock exclusion), enhancing the vegetation, placing a compacted clay seal over bad areas followed with top soil and vegetation, etc. The land should be treated simply as poor farm land, which happened to be previously mined, and needs to be improved.

Many landowners in the Dark Creek watershed have already taken steps on their own to improve the productivity of their land. They may or may not have realized that these good farming practices reduce the amount of Acid Soil Erosion on this previously mined land. Landowners still may have areas where productivity is not as good as they desire and may lack the resources to address these problems. Cost share incentives and education about Best Management Practices may be available through the local Soil and Water District and Natural Resources Conservation Service.

There is a current Agricultural Nonpoint Source (AgNPS) Special Land Area Treatment (SALT) Project for Dark and Sugar Creeks in Randolph County that is able to funnel more resources to the Dark Creek watershed. This seven-year project was initiated in July 1, 2002 with a budget of $750,000. There is a steering committee and many educational activities have already taken place. The July 2004 semi-annual progress report shows that overall the project is 11 percent complete. The department has been working with the Randolph County Soil and Water District by attending meetings with the steering committee and other landowners. These educational meetings discuss a variety of topics, including how the AgNPS SALT goals to reduce soil erosion and increase productivity of the land parallel the goals in this TMDL.

This TMDL will be incorporated into Missouri's Water Quality Management Plan.

10. Reasonable Assurances

The presence of a SALT Project with goals, mileposts and a watershed group provides reasonable assurance that work will be done on the Crutchfield AML area to improve the water quality in the Dark Creek. Also, the department's Water Protection Program will continue low-flow water chemical monitoring of the impaired segment of Dark Creek. Periodic review of the department's Water Quality Management Plans and monitoring data should also provide reasonable assurance that Dark Creek will meet water quality standards. If this monitoring reveals that water quality standards are not being met for sulfate plus chloride (1000 mg/L or less), then this TMDL will be re-opened and re-evaluated.

11. Public Participation

This water quality limited segment of Dark Creek is included on the approved 2002 303(d) list for Missouri. The Missouri Department of Natural Resources' Water Protection Program developed this TMDL.

After the department develops a TMDL, it is sent to EPA for examination and then the edited draft is placed on public notice. The public notice period for the draft Dark Creek TMDL was from October 22 to November 21, 2004. Groups that received the public notice announcement included the Missouri Clean Water Commission, the Water Quality Coordinating Committee, the TMDL Policy Advisory Committee, Randolph County Soil and Water Conservation District, Stream Team volunteers in the watershed (8), the appropriate legislators (2) and others that routinely receive the public notice of Missouri State Operating Permits. A copy of the notice, the comment received and the department response may be found in the Dark Creek file.

12. Administrative Record and Supporting Documentation

An administrative record on the Dark Creek TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources, including the following:

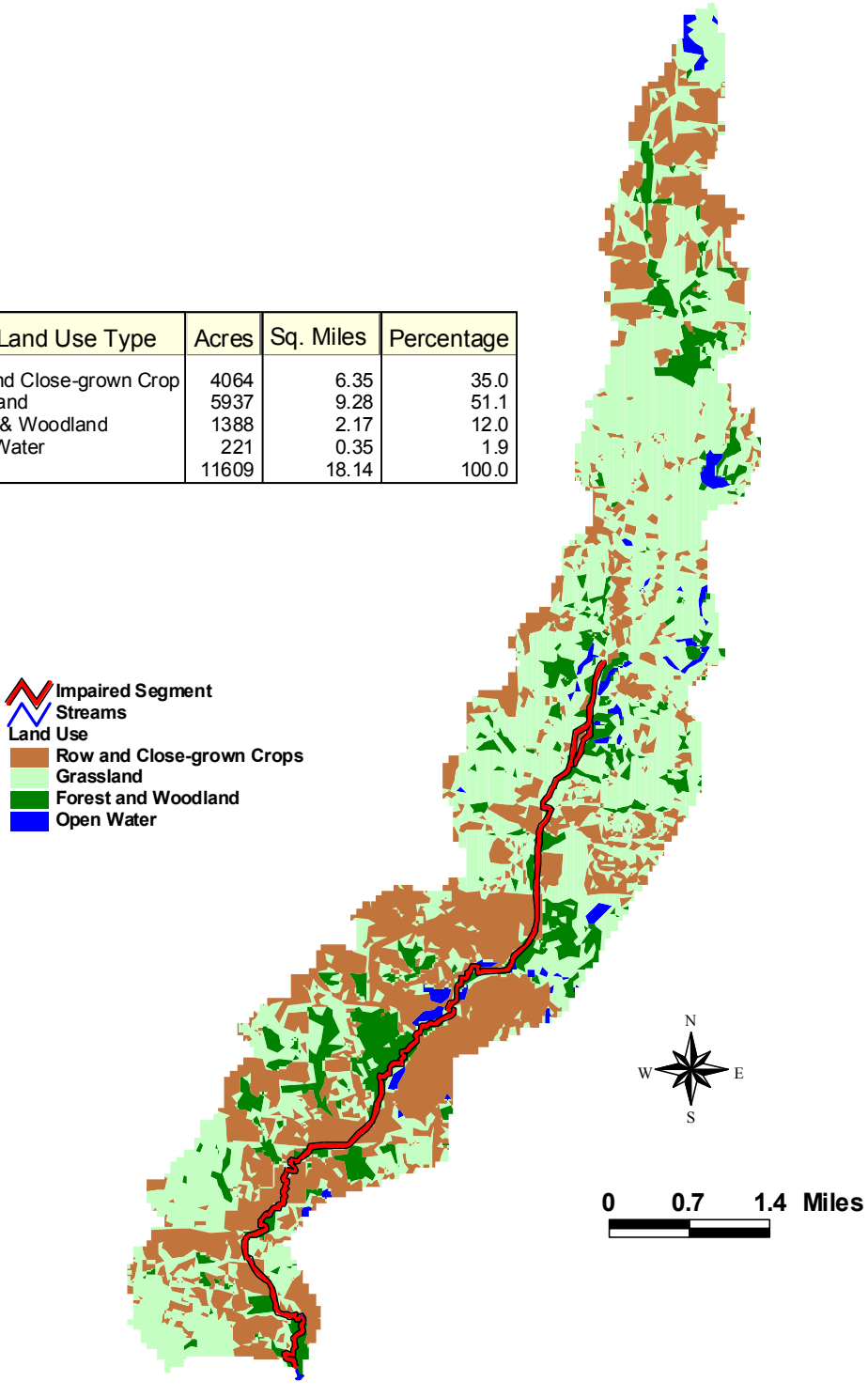
A brief report on the reclamation project
AgNPS SALT Project and Annual Reports
Dark Creek Information Sheet

13. Appendices

Appendix A – Land Use Map
Appendix B – Map Showing the Impaired Segment of Dark Creek with Sampling Sites
Appendix C – Data from Dark Creek (2000 to 2004)

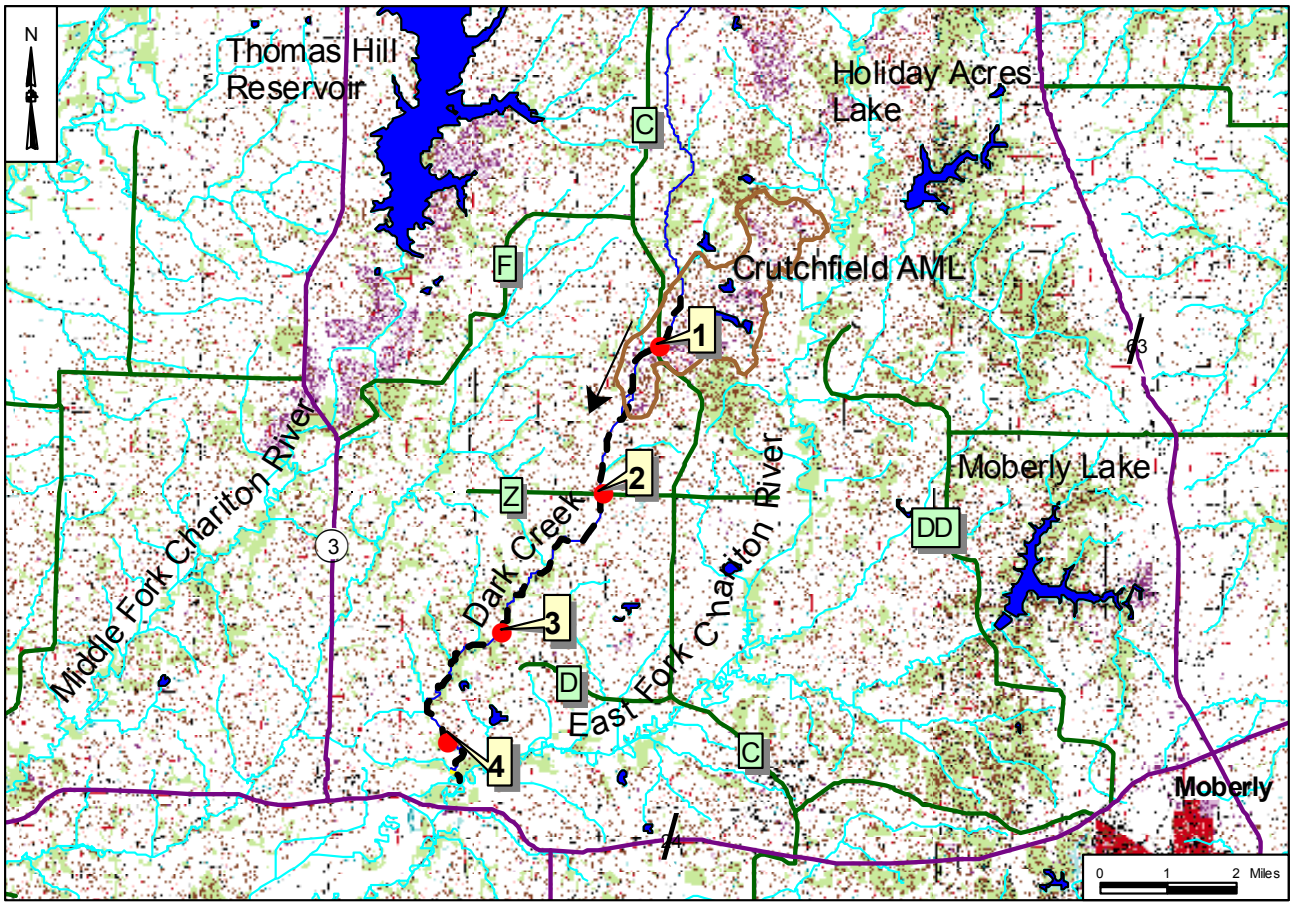
Appendix A: Land Use in the Dark Creek Watershed

Land Use Type	Acres	Sq. Miles	Percentage
Row and Close-grown Crop	4064	6.35	35.0
Grassland	5937	9.28	51.1
Forest & Woodland	1388	2.17	12.0
Open Water	221	0.35	1.9
Totals	11609	18.14	100.0



Appendix B

Impaired Segment of Dark Creek in Randolph County, Missouri, Showing Sampling Sites and the Crutchfield Abandoned Mine Land (AML)



Impaired segment → Direction of Flow

Site Index

1 – Dark Creek at Hwy C, within Crutchfield AML
2 – Dark Creek at Hwy Z, 3 miles below Site 1
3 – Dark Creek 6 miles below Site 1
4 – Dark Creek 8 miles below Site1

Appendix C

Data from Dark Creek (2000 to 2004)

(Numbers in **bold** exceed water quality standards)

Site Number	Site Name	Year	Month	Day	Time	C (Temp)	pH	SC	SO4	Cl	SO4+Cl
1	Dark Creek at Hwy C	2000	3	17	1140	5	7.5	1600	855	41	896
1	Dark Creek at Hwy C	2000	4	24		12	7		1710	15	**1725**
1	Dark Creek at Hwy C	2000	8	18		24	8		1360	19	**1379**
1	Dark Creek at Hwy C	2001	3	6	1015	2	6.8	1220	566	17	583
1	Dark Creek at Hwy C	2001	6	14		23	7	1580	747	17	764
1	Dark Creek at Hwy C	2001	9	4	1330	24	7.2	2630	1190	14	**1204**
1	Dark Creek at Hwy C	2001	10	25	1223	10	7.7	2350	1240	17	**1257**
1	Dark Creek at Hwy C	2001	12	20	1230	4	7.2	2630	1220	23	**1243**
1	Dark Creek at Hwy C	2002	1	10	1035	0.4	6.8	4290	2130	14	**2144**
1	Dark Creek at Hwy C	2002	3	18	1135	8	6.8	1580	664	19	683
1	Dark Creek at Hwy C	2002	6	28	1411	25.7	7.6	2444	738	20	758
1	Dark Creek at Hwy C	2002	9	25	1245	17	7.6	3640	2270	15	**2285**
1	Dark Creek at Hwy C	2002	12	10	1130	3	7.8	4116	2400	13	**2413**
1	Dark Creek at Hwy C	2003	3	12	1115	3	7.9	2800	1710	14	**1724**
1	Dark Creek at Hwy C	2004	3	4	900	5.5	7	1460	580	28	608
1	Dark Creek at Hwy C	2004	5	28	1513	23	7.2	485	96	16	112
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2000	3	17	1415	5	7.4	1250	618	28	646
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2000	4	24		12	7.7		1550	13	**1563**
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2000	8	18		23	7.8	817	245	14	259
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2001	3	6	1110	3	7.6	1080	465	15	480
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2001	7	14		24	7.6	1000	384	14	398
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2001	9	4	1350	25	7.6	1090	449	21	470
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2001	10	25	1245	11	7.8	1322	529	16	545
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2001	12	20	1300	4	7.8	2130	879	18	897
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2002	1	10	1105	0	7.3	3350	1460	15	**1475**
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2002	3	18	1150	8	7.6	1314	541	15	556
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2002	6	28	1421	28.1	7.8	1307	866	12	878
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2002	9	25	1310	18	7.8	1225	511	29	540
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2002	12	10	1150	1	7.6	4234	2600	20	**2620**
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2003	3	12	1140	5	8	2140	1320	15	**1335**
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2004	3	4	920	7	7.6	798	544	20	564
2	Dark Cr. at Hwy Z, 3 mi. bl. Site 1	2004	5	28	1521	22	7.5	410	100	10	110
3	Dark Creek 6 mi. bl. Site 1	2000	3	17	1340	10	7.2	1840	1120	14	**1134**
3	Dark Creek 6 mi. bl. Site 1	2000	4	24		12	7.5		1110	15	**1125**
3	Dark Creek 6 mi. bl. Site 1	2000	8	18		24	8	888	306	10	316
3	Dark Creek 6 mi. bl. Site 1	2001	3	6	1140	4	7.7	879	360	12	372
3	Dark Creek 6 mi. bl. Site 1	2001	7	14		25	7.5	804	299	14	313
3	Dark Creek 6 mi. bl. Site 1	2001	9	4	1405	26	7.5	1400	740	12	752

3	Dark Creek 6 mi. bl. Site 1	2001	10	25	1300	12	7.8	948	352	11	363
3	Dark Creek 6 mi. bl. Site 1	2001	12	20	1315	4	7.8	1970	856	15	871
3	Dark Creek 6 mi. bl. Site 1	2002	1	10	1230	0	7.4	2470	917	18	935
3	Dark Creek 6 mi. bl. Site 1	2002	3	12	1200	8	8.1	1800	1110	13	**1123**
3	Dark Creek 6 mi. bl. Site 1	2002	3	18	1215	8	8	1170	488	13	501
3	Dark Creek 6 mi. bl. Site 1	2002	6	28	1437	26	7.9	1296	580	10	590
3	Dark Creek 6 mi. bl. Site 1	2002	9	25	1335	19	7.6	857	316	10	326
3	Dark Creek 6 mi. bl. Site 1	2002	12	10	1205	1	7.5	2252	1060	15	**1075**
3	Dark Creek 6 mi. bl. Site 1	2004	3	4	935	7	7.6	748	509	17	526
3	Dark Creek 6 mi. bl. Site 1	2004	5	28	1535	22	7.3	462	143	9	152
4	Dark Creek 8 mi. bl. Site 1	2000	3	17	1300	7	7.6	1730	1130	10	**1140**
4	Dark Creek 8 mi. bl. Site 1	2000	4	24		13	7.5		1020	16	**1036**
4	Dark Creek 8 mi. bl. Site 1	2000	8	18		29	8	730	242	10	252
4	Dark Creek 8 mi. bl. Site 1	2001	3	6		2	7.4	782	298	13	311
4	Dark Creek 8 mi. bl. Site 1	2001	7	14		24	7.2	765	274	15	289
4	Dark Creek 8 mi. bl. Site 1	2001	9	4	1405	25	7.4	788	411	10	421
4	Dark Creek 8 mi. bl. Site 1	2001	10	25	1320	12	7.4	816	283	16	299
4	Dark Creek 8 mi. bl. Site 1	2001	12	20	1330	5	7.8	1880	721	15	736
4	Dark Creek 8 mi. bl. Site 1	2002	1	10	1145	0.5	7.3	2370	959	20	979
4	Dark Creek 8 mi. bl. Site 1	2002	3	12	1215	5	8.1	1640	893	14	907
4	Dark Creek 8 mi. bl. Site 1	2002	3	18	1235	8	7.8	1068	425	14	439
4	Dark Creek 8 mi. bl. Site 1	2002	6	28	1447	24.8	7.5	1106	445	11	456
4	Dark Creek 8 mi. bl. Site 1	2002	9	25	1400	22	7.8	1573	748	29	777
4	Dark Creek 8 mi. bl. Site 1	2002	12	10	1225	4	7.4	1910	841	16	857
4	Dark Creek 8 mi. bl. Site 1	2004	3	4	1000	7	7.5	731	429	20	449
4	Dark Creek 8 mi. bl. Site 1	2004	5	28	1555	21	7.3	407	109	9	118

Abbreviations and units of measurement:
Cr.=Creek; mi.=mile; bl.=below
^{0}C=Temperature in degrees Celsius; pH in SU; SC=Specific Conductivity in µS/cm; SO4=Sulfate in mg/L; Cl=Chloride in mg/L.